Outline of the Proposed Research Work Entitled

"SPATIO-TEMPORAL STUDY OF CLIMATIC VARIABILITY IN MARATHWADA REGION: A GEOGRAPHICAL APPROACH"

Submitted to

Swami Ramanand Teerth Marathwada University, Nanded

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"Spatio-Temporal Study of Climatic Variability in Marathwada Region: A Geographical Approach"

1) Introduction:

Agriculture is the prime activity of human being. Today worlds 60% population is engaged in agriculture and according to FAO, it contribute 3 % share in worlds GDP. The agriculture activities influence by physical as well as cultural factors on the Earth. But the physical factors are playing dominant role in agriculture, wiz. Topography, climate, drainage pattern etc. the geography is the study of physical and cultural elements with concern to earth environment. According to the importance of elements and deep study, the geography is divided in to two main branches i.e. Physical and Human Geography. Again those branches divided in to sub branches for micro level study. Climatology is one of branch of physical Geography. The agriculture and climate are closely associated with each other. The numbers of climatic elements are effects on each and every activity of agriculture. Climate is nothing but the result of all weather phenomenons for a long time period. The weather phenomenon includes temperature, precipitation, moisture content, fog, dew, cloud, lighting, wind, air pressure etc. the term climatology is the science that seeks to describe and explain nature of climate how it differ from place to place and how it related to human activities (Critchfield 1975). According to the Riley and Spoltan (1974), is the study of weather condition over a long period. D.S. Lal (2011), the term climatology correctly applied to the study of five growing fields, climatological record, theory of climate, energy and moisture balance of the earth, study of climate as the environment of living organisms and study of climate as the direct environment of man.

The element of climate changes over a time and place. Its result is climate change. Climate change refers to any change in climate over time, weather due to natural variability or a result of human activity (IPCC 2007). The impact of climate change varies regionally.

The climate directly and indirectly affects on Human Activities and Natural Processes through drought, cloudburst, uneven and uncertain rainfall, frost, hailstorm, high temperature and cold waves.

2) REVIEW OF LITERATURE

There are some researcher carried out the study on agro climatic zone, agro ecological zone and some study focused on the conceptualization of vulnerability and its relation with agricultural activities. That study can help to new researchers to study the climate change and agricultural activities and their interrelationship. The literature review gives the direction and ideas to new researcher and also shows the gap in research areas. So the following researchers and scholars focused on various topics related to agriculture and climate.

Ashrit, Raghavendra(2001) Climate change and variability over India : Observations, model simulations and agricultural impacts.

Ashwani Sharma J.N.U., New Delhi (2008), examined in research paper the Impact of Climate Change on production and crops yield in India.

A. Awasthi (1995) studied the description of spatial distribution of climatic elements over a selected area of the Utter Pradesh State. e.g. temperature, rainfall, pressure and winds, humidity and evopotranspiration and their relation to human activities.

Balungi Francis (2010), has been tried to mapping of agro-climatic zone for Sorati district of East Uganda using GIS. In this research paper focused on to assess the climatic suitability of geographical area for various agricultural and alternatives.

Balling, R. C. Jr. and S. B. IDSO, Arizona State University, Tempe, examined the linear change in temperature between1920-1984 is calculated for 961stations in the

conterminous United States. Stepwise multiple regression analysis identifies a statistically significant impact of population change on these temperature trends.

Barry, R.G and R.J. Chorley, (1982) describe of climatic variability, trend and fluctuations of world climatic data.

Dr. Fooroudhsadat Vojdani (1994) explains the Climatic Characteristics of Marathawada Region with relationships of Agriculture.

Dr. S.S. Adsul (2001) describes the Climatic Environment of Bhima Basin with the special reference of Agriculture Activity.

Dr. H.S. Soybam (1990) and Dr. S.R. Ingale (1995) studied the Various Rainfall Charecteristic of Pune district and Goa state respectively.

Greenpeace (2008). Cool Farming: Climate Impacts of Agriculture and Mitigation Potential. Greenpeace compared organic with conventional products for their contribution to climate change.

Hobbs. J.E (1980) examines essential characteristics of the atmosphere, with particular emphasis on its variability in time and space, as a prelude to an investigation, in subsequent chapters, of the ways in which human behavior and activities are related to weather and climate.

H. Cline, William, The Peterson Institute for International Economics (2007). Global Warming and Agriculture: Impact Estimates by Country. This study concludes that within this century, global warming will have a modest negative impact on global agriculture.

Ismail.M. (2012), Studied agro ecological zoning of Egypt by using RS and GIS. In this paper they were examined the capabilities of GIS to determine the agro ecological zones.

Krishna Reddy, P R. (1991) Some aspects of agroclimatology, land use and cropping pattern of the Cuddapah District, Andhra pradesh, India, using remote sensing

Mathaniel Bayode(2014), studied the climate change analysis and Adaptation: The role of Remote Sensing and GIS.

N.R. Patel (IIRS, Dehradun) discussed about Remote Sensing and GIS Application in Agro-ecological zoning in Mountain Ecosystem.

Rafael Battist and Paulo C. Sentelhas (2014); studied the new agro-climatic approach for soyabean sowing dates recommendation: A case study for Brazil.

Research continues on the development of quantitative indicators of climate variability and adaptation to climate-related hazards at multiple scales of analysis (Leichenko and O'Brien 2002; Moss et al. 2002; O' Brien et al. 2004; Brenkert and Malone 2005; Brooks et al. 2005; Sullivan and Meigh 2005; Ericksen and Kelly 2007; Deressa et al. 2008; Torresan et al. 2008; Hahn et al. 2009).

Shrybman, Steven (2000). Trade, Agriculture and Climate Change: How Agricultural Trade Policies Fuel Climate Change. Shrybman argues that the ways in which we assess the impacts of climate change on agricultural production, need to be change in agriculture practices.

Theinnei, Vichai; University of Pune, discussed about Analytical study of the relationship between the agro-climate parameters and the yields of important crops in the Eastern Region of Thailand.

V. Madhava Rao et.al. (2008) examined to Agro-climatic planning and Information Bank (APIB) for Uttarakhand State of India. In their research work they tried to evaluate the agriculture and natural resources inventories by analyzing satellite data, also traced on agro-ecological characterization and agro- climatic regional planning.

Vojdani, Fooroughsadat(1994) Agroclimatic characteristics of marathwada region.

World Bank (2008), Climate Change and Agriculture: A Review of Impacts and Adaptations. Concludes that the countries that are most affected by climate change will have to increase their involvement in international trade as their environment worsens.

3) STUDY AREA

The Marathwada region has been selected for present study. It is one of the administrative regions of Maharashtra state. It lies in upper Godavari basin. It extends form 17035' north latitude to 20040' north latitude and 74040' east longitude to 78016' east longitude. The region bounded by Jalgaon, Wshim and Buldhanaon north, Yavatmal district on north-east, Kamareddi, Nizamabad and Adilabad district of Andhara Pradesh on east, Bidar and Gulbarga district of Karnataka state on south-east, Solapur on south-west and NAshik and Ahamednagar districts on west. East-West maximum length of region is about 394 km. and north-south extent is about 330 km. The entire region is situated at the height of about 300–650 meter above MSL. The study region totally covered 64813 sqkm area, which is 21.00 percent of state. The population of study region is 18727748 it is 16.7 percent of state (2011 census). 72.9 percent rural and 27.1 percent urban population and the region have 289 persons per sqkm area. Administratively the Marathwada region is divided into eight district and 76 tahsils, Aurangabad city is the administrative headquarters of this region. The region Lacks natural resources and is prone to drought. Nearly 32% of its 64,818 sq km area comes under the rain shadow region. The region receives 825 mm average annual rainfall, and drought is a permanent feature. The region experiences three seasons of climate. June to September is the south-west monsoon season, whereas October to December constitutes the post-monsoon season or the retreating monsoon season and the Pre-Monsoon or summer season is from March to the end of May. Jowar is a predominant crop occupying 33% of gross cropped area cotton-22.55%. oilseeds 5.17%, pulses 7.63 %. Kharif jowar /bajra followed by gram, safflower. Area under paddy is increasing. Pulses- tur, mung, udid, gram & lentils. Oilseeds- groundnut, sesamum, safflower & Niger. Sugarcane & summer crops are taken on availability of irrigation. The region experiences Maximum temperature 41^0 C

Minimum temperature 21^0 C. This region found that dry deciduous forests, open scrub jungles and vast tracts of grasslands form the components of vegetation. The region has shallow, medium and deep soils. According to Committee's calculation based on DES data Aurangabad region contributes 10.1 percent GDP to Maharashtra economy (2009-10).

4) OBJECTIVES OF RESEARCH

1. To understand geographical setting of study region.
2. To study the spatio-temporal climatic scenario in study region.
3. To study the natural and cultural factors affecting on climate of study region.
4. To identify Classification of Climate with the help of Koppen and Thornthwaite methods.
5. To study the climatic impact and spatio-temporal variation in agricultural landuse.
6. To demark the agro-climatic regions of study region.
7. To understand the future trend of Climate.

5) DATA COLLECTION

The primary and secondary data will be used for present proposed research work. The primary data will be collected from field visit throughout the year in different season. Other required information will be extracted through face to face interviews of farmers using questionnaires, discussion and observation of study region.

The secondary data will be collected from published and unpublished materials from various offices/departments as Revenue and others. Climatic data collected from National Climate Data Center, Indian Meteorology Department, Pune, daily temperature, humidity, wind velocity data will be collected from various weather data collection stations in study region. Besides this, published records and abstracts such as socio-economic review, Census Handbook, Statistical Report of District, Crop and Seasons Report, Gazetteer, Agricultural Bulletin Published by Agriculture Department,

Maharashtra State, Pune. Periodicals and other documents will be used for obtaining relevant data and information bearing on the theme.

For Preparation of base maps and other maps the topographical map will be gathered from Survey of India,

Required suitable satellite data will be collected from NRSC Hyderabad.

6) METHODOLOGY

In the study region there may be Spatio-temporal variation in climatic characteristics. For this proposed study, climatic station has been considered as a unit for data analysis. Other relevant tools will used for further analysis.

Following methods will be used in data analysis of present research work.

1. Mean of Climatic data= $\overline{X} = \frac{\Sigma x}{n}$

   Where the mean of x is the sum of its values divided by the number of values there are.

2. Rainfall Variability - C.V. = S/M *100

   Where C.V.is co-efficient of variability, S is the standard deviation, M is the mean annual rainfall for 50 years.

3. Coefficient of Variability= S.D/Average*100%.

4. Rainfall intensity I=P/N

   Where P is the total amount of rainfall and N is the number of rain days.

5. Annual temperature range= Difference between the warmest and coldest month.

6. Relative Humidity= e/es

   Where e for vapour pressure, es for saturation vapoure pressure.

   Or

   R.H. = Vapour pressure/saturation vapour pressure*100

7. Trend Analysis and Moving Average Methods $MA = \frac{(P_1 + \ldots + P_n)}{n}$

8. Standard Deviation. $S = \sqrt{\frac{\Sigma(X - \overline{X})^2}{N}}$

where S = the standard deviation of a sample,
Σ means "sum of,"
X = each value in the data set,
X = mean of all values in the data set,
N = number of values in the data set.

9. Correlation coefficient $$r = \frac{n(\Sigma xy) - (\Sigma x)(\Sigma y)}{\sqrt{[\,n\Sigma x^2 - (\Sigma x)^2\,][\,n\Sigma y^2 - (\Sigma y)^2\,]}}$$

Where:
- N = number of pairs of scores
- Σxy = sum of the products of paired scores
- Σx = sum of x scores
- Σy = sum of y scores
- Σx² = sum of squared x scores
- Σy² = sum of squared y scores

10. Regression Analysis: **y' = a + bx**

$$a = \frac{(\Sigma y)(\Sigma x^2) - (\Sigma x)(\Sigma xy)}{n(\Sigma x^2) - (\Sigma x)^2}$$

$$b = \frac{n(\Sigma xy) - (\Sigma x)(\Sigma y)}{n(\Sigma x^2) - (\Sigma x)^2}$$

11. Soil Moisture Index= P/PE

    Where P for precipitation and PE for Potential Evapotranspiration.

    In this present studies, use the criteria for the classification of different zones based upon Moisture Index viz. Arid =0.05-0.20, Semi Arid =0.21-0.5 and Dry Sub Humid = 0.51-0.65) is used.

12. Probability Analysis.
13. Classification of climate according to Koppen and Thornthwaite's method.

    Rather than, the various cartographical, quantitative, remote sensing, GIS and GPS techniques will be used in the research work, for this purpose software like ArcGIS, ERDAS IMAGINE, Global Mapper, Map source, SPSS, Minitab, Corel draw, Instat Climatic Guide, TEMPTURE.xls, HYDROSTAT_Simple.xls and MS office, will be applied to data analysis.

7) IMPORTANCE AND SCOPE OF THE STUDY

The study region located at eastern side of Sahyadri Mountain, it is rain shadow area. It experiences very low rainfall throughout the year. Industrially this region is less developed as compare to other part of Maharashtra. Hence it has very rear network of transportation. The climate of region is temperate and dry. Due to this climatic condition the agriculture development is very less. Drainage network and irrigation facilities are absent. The agriculture is the major activity in study region. And

this activity influences by climate. It plays major role in districts total economy. So it is very much important to study the climatic condition and agricultural landuse pattern, and the relationship between them. The present study will help to understand the relationship between cropping pattern and climate, the influences of other factors, like Soil, water supply and technology, represented by mechanization, pest and disease control, and the other agricultural management aspects. Although these factors are crucial in agriculture and crop yield, the interest of this study is concentrated on the effect of the climatic factor alone. This is not intended to minimize the influence of the other factors. Many difficulties stand on the way of including other variables affecting agriculture and crop yield in statistical model quite apart from the difficulty of designing a totally comprehensive multivariate model.

India's growth-inclined position on climate change appears legitimate. But with the potential to radically alter India's economy, and reshape the human security terrain and even the geopolitical order of south Asia, climate change is an issue on which India has perhaps the greatest to lose. Despite the importance of economic growth, "rising India" and inclusive development are not mutually exclusive. Adaptation to inevitable environmental shifts is necessary; political adaptation - including unity amongst the estranged south Asian neighbor is imperative to manage the political and security-oriented consequences of climate change. The Intergovernmental Panel on Climate Change has confirmed that climate change is real, has quantified its magnitude and future evolution, and has assessed its impact. The 2006 Stern report concluded that the economic costs of climate change are significant. There are many ways to mitigate climate change, and results of action undertaken through the Kyoto Protocol are now visible. We will try to examine alternative policies for mitigating and adapting to climate change.

8) PROPOSED WORK PLAN

- **First year plan**

1.Review of Literature: To approach this study, a review of published literature, books and journal on relevant subject as well as unpublished material from different researchers and Institutions specific to study area will be carried out.

2. Field work and Data collection: The climatic data will be collected from various primary and secondary sources with the help of field work, survey, interview and other methods.

3. The basic information will be collected and written.

- **Second year plan:**

Collected climatic and agricultural data related to our research will be analyzed and tabulated with the help of various statistical techniques and later on it will be analyzed and visualize with the help of cartographical, GIS, GPS and Remote Sensing techniques using various software's.

- **Third year plan:**

1) Interpretation of climatic and agricultural data: The climatic data will be interpreted in this year for the final conclusion.
2) Writing and submission of thesis: The thesis will be written after the interpretation of data and achievement of objectives and will be submitted at the end of third year.

9) DESIGN OF RESEARCH WORK

The entire research work will be design in to the following chapters.

Chapter 1st "**Introduction**" will be consists of definition and concept of Climatology, Agriculture, Agriculture Meteorology, introduction of study area, selection of problem, Aims and objectives of the study, methodology, database and review of literature.

Chapter 2nd entitles "**Physical and Cultural environment of the Marathwada Region**." associated with the Location, Physiography, relief, geological structure, drainage systems, soils , Natural Vegetation Population, Transportation, Economic Activity in the study region.

Chapter 3rd Deals with "Climatic Scenario" it includes the spatial and temporal variation of rainfall, temperature, humidity, cloud condition, wind situation, evaporation etc.

Chapter 4th Highlighted the "Factors affecting on climate of Marathwada", it will cover the relation between climate and topography, vegetation, slope, drainage system, temperature etc.

Chapter 5th is "**Climate and Agricultural Landuse**" this topic are highlighted the relationship of climate and agriculture with reference to cropping pattern and Yields in the study area.

Chapter 6th is allocated to "**Agro-climatic analysis of study region**" in order to make simplification and generalization of the knowledge about the agro climatic condition and agro climatic zones.

Chapter 7th deals with "**Summary and Recommendations**." highlighted Summarization with conclusion and recommendations.

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